

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: : Afzali-Ardakani et al.
Serial No. : 08/118,475
Filed On : September 7, 1993
For : ELECTRICALLY CONDUCTIVE
POLYMERIC MATERIALS AND
USE THEREOF.
Examiner : Greg Del Cotto
Group Art Unit : 1105

Honorable Commissioner of Patents
and Trademarks
Washington, D.C. 20231

DECLARATION UNDER 37 C.F.R. §1.132

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Dear Sir:

MARIE ANGELOPOULOS declares as follows:

1. I am one of the inventors of the subject matter of the above-identified patent application.
2. I received a Bachelor of Arts degree in Chemistry in 1982 from Rutgers, the State University. In 1988, I was awarded the degree of Doctor of Philosophy in Chemistry from the University of Pennsylvania.
3. From 1987 to date, I have been employed by the International Business Machines Company, Thomas J. Watson Research Center, Yorktown Heights, New York, assignee of the above-identified application. My present position is Research Staff Member, Advanced Polymer Materials.
4. I have reviewed the Office Action dated April 15, 1996 from the United States Patent Office Examiner relating to the above-identified application.
5. In the aforementioned Office Action, the Examiner has rejected Claims 53-81 as being unpatentable over each of United States Patents 4,933,106 to Sakai et al., 4,940,517 to Wei, 5,068,060 to Jen et al. or 4,771,111 to Tieke et al. In the Office Action the Examiner has stated:

“The present claims are drawn to an electrically conductive composition containing an electrically conductive polymer and a polymer dopant, the method of making such a composition and articles formed therefrom. The electrically conductive polymer and the polymer dopant can be selected from lists of well known conductive polymers and well known polymer dopants. Each of the references listed above teach (sic) an electrically conductive composition containing an electrically conductive polymer and a polymer dopant as taught by applicant. Each reference teaches at least one embodiment of applicant’s invention. While some of applicant’s dependent claims recite a specific conductive polymer with a specific dopant, nothing unobvious is seen in merely selecting a conductive polymer and a polymer dopant from the lists of materials that are taught by the prior art.

Sakai discloses an electrically conductive composition, and method of making such, comprising a conductive polymer and a polymer dopant, which can be the same as those presently claimed. See columns 2 and 3. For example Sakai teaches polypyrrole and polythiophene as polymers and teaches polyacrylic acid, polysulfonic acids and acids containing carboxylic groups as dopants. It would have been *prima facie* obvious for one skilled in the art to make an electrically conductive composition out of any combination of these polymers and dopants as Sakai clearly suggests that such may be done.

Wei discloses an electrically conductive composition, and method of making such, comprising polyaniline and a polymer dopant. The dopant can be polysulfonic acid or polyacrylic acid. See column 4, lines 4-8.

Jen discloses an electrically conductive composition, and a method of making such, comprising a polymer (heterocyclic vinylene) and a polymer dopant. The dopant can be *sic* (be) polyacrylic acid and those containing carboxylic acid or sulfonic acid groups. See abstract and column 14, lines 57-65.

Tieke discloses an electrically conductive composition comprising a mixture of polyimide and polypyrrole. See abstract examples.

While all of the references do not contain a specific example teaching an electrically conductive polymer and a polymer dopant, the suggestion to do so is clearly suggested in each patent. The skilled artisan would simply expect that the polymer dopants would produce results similar in degree to the other dopants listed and specifically demonstrated. Nothing unobvious is seen in doing so. Additionally, note that each reference teaches the shaping of the polymer material into useful articles.”

The Examiner has also cited the reference to Li et al. but concedes that they do not exemplify the composition as instantly claimed.

6. I have been involved in the science and technology associated with conductivity of polymers for the past ten years. I make this declaration to establish that there is a difference in the structure between the blend of the present invention and the structure of the polymers disclosed in the prior art cited above. I, and others skilled in the art of conducting polymers, know that the processing of constituent polymers in the blend has a significant impact on the properties of these polymers, including their solubility conductivity, optical properties, etc. As a result, polymers that possess identical nomenclature, in fact are different and have different properties.

7. To provide support for the assertion made above, I refer to an article authored by A. G. Mac Diarmid et al. who are disinterested third parties to this matter, in *Synth. Met.* **65**, 1994, pps. 103-116. A copy of this article is attached as Exhibit A. These authors reported that a polyaniline doped with camphorsulfonic acid possesses dramatically different conductivities and optical properties when prepared in chloroform solvent as opposed to m-cresol solvent. The Mac Diarmid article supports applicants' position that chemical composition may appear to be the same, but the properties of these same compositions are substantially different based upon the molecular structure of same.

8. Based upon my research, it is the molecular structure that controls the properties of conducting polymers. Molecular structure includes, but is not limited to, the chain conformation of the polymer, the interchain configuration and the polymer chain packing.

9. As a result of the rejections in the Office Action dated April 15, 1996 detailed above, I again reviewed the prior art references cited by the Examiner to Sakai et al., Wei et al. and Tieke et al. and reiterate that they all teach the in-situ polymerization of monomers such as aniline, pyrrole, etc. in the presence of an electrolyte such as a polyacid.

10. Using the Wei et al. reference as representative of the teachings of the three prior art references noted above, I duplicated the process described in Example 1 of the Wei et al. reference using an addition polymerization process by polymerizing aniline monomer with ammonium peroxydisulfate in the presence of polystyrenesulfonic acid in aqueous solution.

11. More specifically, a stoichiometric amount of aniline was added to a 15% aqueous solution of polystyrenesulfonic acid wherein the molar ratio of aniline to polystyrenesulfonic acid is 1:1. Upon the addition of the oxidant, ammonium peroxydisulfate, a precipitate formed immediately. Attempts to dissolve the precipitate were unsuccessful.

12. Also following the method of Wei et al., Example 1, I also polymerized: a) aniline monomer in the presence of ammonium peroxydisulfate and polyacrylic acid in aqueous solution; and b) aniline monomer in the presence of ammonium peroxydisulfate and polyamic acid in acetonitrile solution. In each case, I found experimentally that once the polymer precipitated out of solution, it did not subsequently dissolve to any appreciable extent in an organic solvent.

RESULTS

13. To demonstrate the unexpected results obtained using the present invention teaching compared with prior art, I prepared an NMP solution of polyamic acid. The solution of polyamic acid was prepared using the procedure described in Example 1 of the specification. A solution of the conducting polymer precursor (i.e. the polyaniline) was prepared in NMP. The dopant solution of the polyamic acid was added to the polyaniline solution with vigorous stirring. The polyamic acid dopes the polyaniline to the doped form resulting in a conducting polyamic-polyaniline blend in which the constituents remain in solution and do not precipitate out. I observed the preparation of the blend and I have determined experimentally that with respect to the present invention, at no time does the conducting polymer blend precipitate from solution. That is, the precursor polymer (the conducting polymer in undoped form) and the polyacid are both soluble in a given solvent. The reaction of the two is carried out in solution, and the product, which is the conducting polymer remains soluble in the given solvent. This result is clearly different from and unobvious in view of the prior art.

14. Unlike the results of the present invention, in each instance where the method of Wei et al. was followed, (as they point out in their patent) polyaniline/polyacid precipitated out of solution. This result is significant and demonstrates a difference in kind since one of applicants' preferred embodiments uses polyamic. (See specification, page 23, Example 1.)

15. I have determined experimentally that the polymer resulting from the Wei et al. method cannot be dissolved because the Wei et al. polymer blend systems forms an interpenetrating system in which significant interchain interaction exists between polymer chains.

16. By way of contrast, Applicants have eliminated the insolubility problem inherent in the prior art. Applicants attain a different conducting polymer structure using the same components but a different molecular structure. This is accomplished using a different process.

17. The structure of Applicants' blend is different from that of the *in-situ* polymerized blends described above. The products possess different properties. The prior art blends are insoluble, whereas Applicants' product is soluble.

18. Analytical tests were conducted on the products resulting from the preparation procedures described above. The conductivity of the *in-situ* products of Wei et al. as representative of the prior art was determined to be 10^0 S/cm whereas the conductivity of the instant invention wherein the polymer solutions were blended was 10^{-3} S/cm.

19. I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true: and further, that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under §1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the above-referenced application or any patent issuing thereon.

Date: August 15, 1996


MARIE ANGELOPOULOS

MAILING CERTIFICATE

Date of Deposit: August 15, 1996

I hereby certify that this amendment with fee
is being deposited with the United States
Postal Service under 37 CFR §1.10 on the date
indicated above and is addressed to the
Commissioner of Patents and Trademarks,
Washington, D.C. 20231
Thomas A. Beck
Person Mailing


Signature